ATOMS AND ISOTOPES REVIEW

A. Select the word that best fits the definition given.

1. *atoms* — the smallest unit of a chemical element that has all the chemical properties of that element
2. *nucleus* — the bundle consisting of protons and neutrons, which is found in the center of an atom
3. *isotopes* — atoms of an element containing the same number of protons, but different numbers of neutrons
4. *proton* — a part of an atom with a positive charge
5. *electron* — a part of an atom with a negative charge

B. Indicate whether each statement is true (T) or false (F) by circling the correct letter. If the statement is false, correct it to make it true.

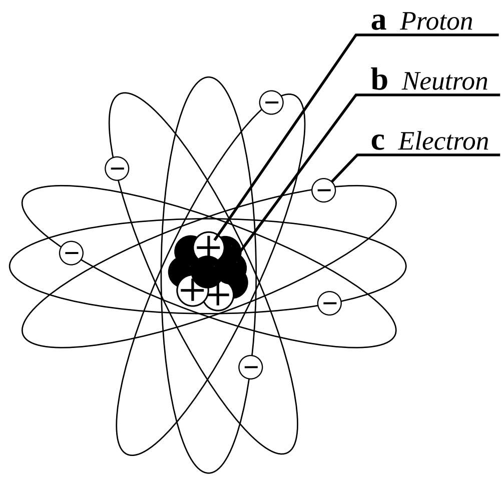
1. Unstable isotopes can change from one form to another by emitting particles and rays. T F
2. An atom is identified by the number of protons in its nucleus. T F
3. Protons and electrons together make up the nucleus of an atom. T F
   (Protons and neutrons)
4. Atoms are so small that humans cannot see them. T F
5. Atoms combine to form molecules. T F

C. Using the periodic table, tell which elements make the molecules of the following substances.

1. H_2SO_4	*hydrogen*	*sulfur*	*oxygen*
2. $C_6H_{12}O_6$	*carbon*	*hydrogen*	*oxygen*
3. KOH	*potassium*	*oxygen*	*hydrogen*
4. $AgNO_3$	*silver*	*nitrogen*	*oxygen*
5. $ZnCl_2$	*zinc*	*chlorine*	

D. Models

1. Label the model of the carbon atom shown to the right. An atom of carbon has 6 protons, 6 neutrons, and 6 electrons. Remember that protons have a positive (**+**) charge, electrons have a negative (**-**) charge, and neutrons have no electrical charge.



2. Draw a model of a helium atom. An atom of helium has 2 protons, 2 electrons, and 2 neutrons. Show protons as **+** , electrons as **-** , and neutrons as .

CHEMICAL ELEMENT WORKTABLE

DIRECTIONS: Using the list of elements and symbols and the Periodic Table, fill in the chart below. The first example has been completed for you.

Element	Symbol	Atomic Number	Atomic Weight	Atomic Weight (rounded off)	No. of Protons	No. of Neutrons
Gold	Au	79	196.9670	197	79	118
Helium	*He*	*2*	*4.0026*	*4*	*2*	*2*
Carbon	*C*	*6*	*12.0111*	*12*	*6*	*6*
Uranium	*U*	*92*	*238.0400*	*238*	*92*	*146*
Radium	*Ra*	*88*	*226.0000*	*226*	*88*	*138*
Plutonium	*Pu*	*94*	*242.0000*	*242*	*94*	*148*
Oxygen	*O*	*8*	*15.9944*	*16*	*8*	*8*
Radon	*Rn*	*86*	*222.0000*	*222*	*86*	*136*
Nitrogen	*N*	*7*	*14.0067*	*14*	*7*	*7*
Calcium	*Ca*	*20*	*40.0800*	*40*	*20*	*20*

CHEMICAL ELEMENT WORKTABLE

DIRECTIONS: Name the isotopes by filling in all the blanks below.

Isotopes of a given element are atoms with nuclei that have the same number of protons, but different numbers of neutrons. An isotope is identified by the sum of the number of protons and neutrons in its nucleus. To find the symbol, use the list of elements and symbols. To find the correct number of protons, use the periodic table.

The first example has already been completed.

Element	Symbol	Number Protons	Number Neutrons	Name of Isotope
Uranium	U	92	143	Uranium - 235
Uranium	*U*	*92*	146	*Uranium - 238*
Carbon	*C*	*6*	8	*Carbon - 14*
Iodine	*I*	*53*	78	*Iodine - 131*
Strontium	*Sr*	*38*	52	*Strontium - 90*
Cesium	*Cs*	*55*	82	*Cesium - 137*
Thorium	*Th*	*90*	142	*Thorium - 232*

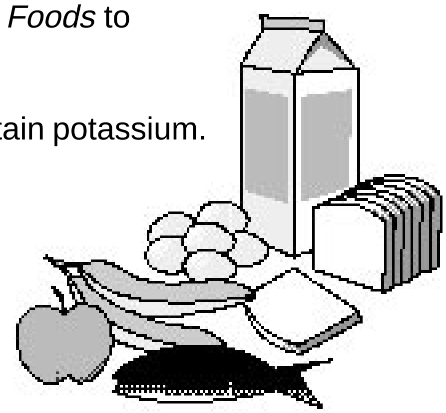
RADIOACTIVITY IN FOOD

Many of the foods that we eat contribute to our internal exposure to radiation. These foods are naturally radioactive. They contain elements like potassium and carbon that are essential for good health and cannot be eliminated from our diets.

Potassium-40

Potassium-40 is a radioactive isotope of naturally occurring potassium. Potassium-40 contributes 18 millirem to our average annual internal radiation exposure.

Directions: Use the chart entitled *Potassium Content and Potassium-40 Activity in Some Selected Foods* to answer the questions that follow.



1. List four foods you have eaten this week that contain potassium.
   (Answers will vary.)

2. If the radioactivity of 1 gram of natural potassium is 30 disintegrations per second (d/sec) and a small banana contains about 0.4 grams of natural potassium, what is the number of disintegrations per second of this banana?

$$\frac{1 \text{ gram}}{30 \text{ d/sec}} = \frac{0.4 \text{ grams}}{x \text{ d/sec}}$$

$$\frac{(1 \text{ gram})(x \text{ d/sec})}{1 \text{ gram}} = \frac{(0.4 \text{ grams})(30 \text{ d/sec})}{1 \text{ gram}}$$

$x = 12$ d/sec

3. The activity of the radioactive potassium-40 in your body is about 60 disintegrations per second per kilogram (d/sec/kg) of body weight.

   a. How much do you weigh? (in pounds) *(Answers will vary.)*

   b. If 1 kilogram (kg) = 2.2 lbs., how much do you weigh in kilograms? *(Answers will vary.)*

$$\frac{1 \text{ kg}}{2.2 \text{ lbs}} = \frac{\text{weight of student in kg}}{\text{weight of student in lbs}}$$

c. Given the activity of potassium-40 above, what is the activity of potassium-40 in your body in disintegrations per second (d/sec)? *(Answers will vary.)*

$$\frac{60\ \text{d/sec}}{1\ \text{kg}} = \frac{\text{activity of potassium (d/sec)}}{\text{weight of student in kg}}$$

Carbon-14

The second largest contributor to our annual internal exposure is carbon-14, a naturally occurring radioactive isotope of carbon. It contributes about 1.2 millirem to our average annual internal radiation exposure.

4. Our bodies are about 23 percent carbon by weight. Because it contains some carbon-14, the carbon in your body has an activity of 227 disintegrations per second per kilogram.

a. Based on your weight in kilograms (from question 3b), how much of your body is carbon? Express your answer in kilograms of carbon. *(Answers will vary.)*

$$\frac{23}{100} = \frac{\text{kg carbon}}{\text{weight of student in kg}}$$

b. Given the activity of carbon-14 in the carbon of your body, what is the total activity of the carbon in your body? *(Answers will vary.)*

$$\frac{227\ \text{d/sec}}{1\text{kg}} = \frac{\text{activity of carbon (d/sec)}}{\text{weight of carbon in kg}}$$

Carbon, Potassium and Your Health

5. Should you try to eliminate all potassium or carbon from your diet in an effort to reduce your annual internal exposure to ionizing radiation? Why or why not?
(No, you should not. Potassium is important for maintaining the proper pressure and balance within the cells of your body. Potassium is also important for your nerves, muscles, and heart to function properly. Carbon is important in providing the heat and energy necessary for our bodies to function.)

Jet Flight Exposure

Because the atmosphere gets less dense as the elevation increases, the cosmic radiation dose rises with increasing elevation. Therefore, passengers on a jet airplane receive an additional dose from cosmic rays during the flight. According to the National Council on Radiation Protection and Measurements, cosmic exposure at 11,887.20 meters (39,000 feet) is 0.5 millirem per hour.

Directions: Figure the radiation exposure from cosmic radiation for the jet flights listed below.

Flight	Round Trip Flight Time	Radiation Exposure
San Francisco to Washington, DC	12 hours	*(6)* millirem
Atlanta to Chicago	4 hours	*(2)* millirem
Dallas/Ft. Worth to Chicago	4 hours	*(2)* millirem
Boston to Los Angeles	10 hours	*(5)* millirem
Chicago to Honolulu	18 hours	*(9)* millirem
New York to Las Vegas	10 hours	*(5)* millirem

Cosmic Radiation

Cosmic rays originate outside the Earth's atmosphere and are composed of highly penetrating radiation of all sorts, both particles and rays. At sea level, the average annual exposure from cosmic rays is 26 millirem. The following table shows the effect of elevation on cosmic ray exposures.

Effect of Elevation, in Feet, on Cosmic Radiation Exposures (MREM/YR)
(exposures reflect 10% reduction for shielding from buildings/structures)

0 (sea level)	26	4,000	39
500	27	6,000	52
1,000	28	8,000	74
2,000	31	10,000	107

Directions: Using the data in the table above, calculate the cosmic ray exposure where you live and the exposure from cosmic rays for the cities listed below. (Check an atlas for the elevation above sea level of your area.)

Place	Elevation	Exposures from cosmic rays mrem/yr
Your home town		
Atlanta, GA	1,050	*(28)* millirem
Minneapolis, MN	815	*(28)* millirem
Salt Lake City, UT	4,400	*(42)* millirem
Spokane, WA	1,890	*(31)* millirem

Apollo Flight Exposure

As previously mentioned, U.S. astronauts in Earth orbit or on Moon missions received increased radiation exposure from cosmic rays. The following table shows the estimated exposures by our astronauts on the various Apollo missions. The data are taken from a 1982 report of the United Nations Scientific Committee on the Effect of Atomic Radiation (UNSCEAR) entitled *Ionizing Radiation: Sources and Biological Effects*.

Directions: In the table below, calculate the average rate of exposure in millirem per hour for the various missions.

Estimated Doses Received by Astronauts on the Apollo Missions

Apollo Mission Number	Launch Date	Type of Orbit	Duration of Mission (Hours)	Exposure	
				Total (mrem)	Rate (mrem/hr)
VII	August 1968	Earth orbital	260	120	*(0.46)*
VIII	December 1968	Circumlunar	147	185	*(1.26)*
IX	February 1969	Earth orbital	241	210	*(0.87)*
X	May 1969	Circumlunar	192	470	*(2.45)*
XI	July 1969	Lunar landing	182	200	*(1.10)*
XII	November 1969	Lunar landing	236	~200	*(0.85)*
XIV	January 1971	Lunar landing	286	~500	*(1.75)*
XV	July 1971	Lunar landing	286	~200	*(0.70)*

MANMADE RADIATION SOURCES

1. True or False: In the blank before the sentence, write T if the statement is true and F if it is false. If the statement is false, correct it to make it true.

The following questions are based on the graph titled *Some Exposures from Manmade Sources Compared to the Average Natural Radiation Exposure.*

F a. The exposures from manmade sources shown in the graph are based on the lowest exposures. *(highest)*

T b. The highest exposure to manmade sources of radiation is from smoking cigarettes.

T c. There is more exposure from building materials than from storage of low-level waste.

F d. The only energy use that results in any exposure to radiation is related to nuclear powerplants. *(There is exposure from use of coal and natural gas.)*

2. List 3 consumer goods that are related to radiation exposure.

(cigarettes

lantern mantles

fertilizer, building materials)

3. Write a sentence or two explaining what you think is the source of radioactivity at coal-fired powerplants, construction activities, and fertilizers.

(The source of radioactivity from coal-fired powerplants, construction activities, and fertilizers is the Earth. The radioactivity in rocks and soil is due to the natural presence of potassium - 40 and elements of the uranium and thorium series.)